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ABSTRACT

This paper examines how the careers and research activities of university scientists in India, Nigeria, and Kenya are influenced by factors related to practicing science in developing nations. Data are derived from interviews with engineers, physicists, mathematicians, and zoologists in Indian, Kenyan, and Nigerian universities. Estimates are that there are approximately 90,000 university scientists in India, 3,000 in Nigeria, and fewer than one thousand in Kenya. Science-related differences among the three nations include volume of scientific work, amount of scientific training available, date of modern scientific development, and effort to relate science planning to national development. In all these cases, India is the most developed. There are, however, many factors common to science teaching and research in these and other developing nations. Common factors include intellectual isolation, peripheral nature of production and circulation of scientific knowledge within the international scientific community, ill equipped and/or poorly maintained scientific facilities, inadequate research funding, and political interference. The conclusion is that scientists in universities in developing nations will contribute more to international scientific endeavors and will be more highly regarded within their own universities if they improve communications with research centers in scientifically developed nations, develop infrastructures for scientific work outside universities, concentrate on training scientific expertise, and award university science teachers with salary raises and promotions on the basis of merit rather than seniority. (DB)

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Scientific Life in Indian and African Universities: A Comparative Study of Peripherality in Science

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Scientific Life in Indian and African Universities: A Comparative Study of Peripherality in Science

This paper examines how the careers of university scientists in India, Nigeria and Kenya are influenced by factors intrinsic to science as well as to its practice in these countries. In regard to the international production and circulation of scientific knowledge, Indian, Nigerian and Kenyan universities are peripheral, i.e., their contributions to science are peripheral to "metropolitan" universities whose research and instructional preoccupations shape scientific activity elsewhere. In varying degrees, universities in the three countries are intellectually isolated due to their history and geography and to deficiencies in the networks of scientific communication linking metropolitan scientific centers with scientific institutions in India and Africa.

India, Nigeria and Kenya differ in the size, composition and evolution of their scientific communities. India has the most developed scientific community in the Third World. With respect to the number of publishing scientists and volume of scientific work, India ranks among the industrial Western nations. (In terms of the production of scientific publications, for instance, Indian scientists published nearly seven thousand scientific papers in 1973, the last year for which comparative information is available.[1] India ranked eighth in the world, ahead of such countries as Australia and Italy).[2] It has the largest number of scientific institutions and the largest scientific population in the Third World.

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At the time of its independence (1947), Inida was an industrial nation, possessing many institutions engaged in scientific instruction and research. Science was integrated into the framework of Indian higher education, in the mid-19th Century at the time of its emergence in many European and North

American universities. Long before independence was obtained, India's scientific community was predominantly Indian. India offered scientific training at the graduate and post-graduate levels, and the state of science was sufficiently advanced for an Indian to be awarded a Nobel Prize for research carried out in an Indian scientific institution established by an Indian philanthropist. In many respects, Indian scientific activity today exhibits features similar to those obtaining in the scientifically "developed" European and North American countries. One important similarity is that much scientific research and development now takes place outside universities. It also exhibits, by virtue of its colonial heritage, the "underdeveloped" infrastructure for scientific work characteristic of other newly independent countries.

The scientific communities of Nigeria and Kenya are among Black Africa's largest. They rank seventh (Nigeria) and twelfth (Kenya) among Third World producers of science and are the most active scientific communities in Black Africa.[3] Their contribution of scientific papers to internationally influential scientific publications is much greater than that of other Black African countries as well.[4] Nigeria's and Kenya's scientific communities are small in comparison to India's. While the number of Indian scientists and engineers involved in research and development is estimated to exceed ninety thousand, Nigeria's scientific community numbers less than three thousand and Kenya's fewer than one thousand.[5]

Both African countries are still reliant, in varying degrees, on expatriate scientific expertise. This is especially evident in the staffing of Faculties of Science in Nigerian and Kenyan universities which are the locus of most scientific research in these countries. In addition, Nigeria and Kenya lag behind India in the establishment of an infrastructure of scientific societies and journals that facilitate professional communication internally as well as with

other scientific communities.[6] The lack of suitable forums for scientific communication is particularly serious in Kenya, where the small number of research scientists has inhibited the development of specialized journals in most scientific fields and of scientific societies organized along disciplinary lines. Significantly, only one scientific journal published in Black Africa (in Kenya) is mentioned in the Science Citation Index which surveys the world's most influential scientific publications.[7] Finally, in contrast to India, Nigeria and Kenya have only recently established mechanisms for national science planning.[8] India's first efforts to coordinate scientific research in the service of national development predate independence (the Council for Scientific and Industrial Research, for instance, was created in 1942). And, since 1969 science planning has been a cabinet level responsibility discharged by a permanent secretariat. Science planning was introduced in Kenya and Nigeria nearly a decade later.

Social studies of science have focused mainly on North American and European countries whose contributions to science overshadow those of other nations. Nevertheless, it is now recognized that the number of participants in the international scientific system has increased enormously as former colonies seek to become politically and scientifically more independent. Further, the relative dominance of western countries, particularly the United States, is diminishing.[9] Studies of peripheral scientific communities---specifically, the scientific communities of Asia and Africa--have characterized scientific activity there as "underdeveloped".[10]

Much has been written about the difficulties Asian and African scientists experience in carrying out their work. Scientific facilities are ill-equipped and/or poorly maintained. Research funding is sporadic, inadequate, and

provided with little appreciation of the importance of research of a long term, fundamental nature. Scientists work in isolation, lacking the "critical mass" of scientific expertise necessary for intellectual stimulation and collegial recognition. The administration of science in universities, government research institutes and other scientific organizations is highly bureaucratized, the result of colonial legacies embraced with enthusiasm and fused with the conviction that the importance and expense of scientific inquiry merits close supervision. The impression these studies create is of a special kind of science-"underdeveloped science"-a pale reflection of what occurs in more developed countries.[11] The role of such scientific communities in the international scientific system is depicted as being peripheral and their peripherality exacerbated by policies favouring indigenization of scientific expertise and involvement in national development.[12]

In subsequent sections of this paper, I will analyze the careers of Indian, Nigerian and Kenyan university scientists in relation to historical and social influences on scientific work. In the following section, I will describe the development of Indian, Nigerian and Kenyan universities with particular attention to how western intellectual traditions have been reinterpreted and expressed in ways, appropriate to Indian and African societies, that profoundly change the context and meaning of scientific work. This will be illustrated later in a comparison of the careers of university scientists in India, Nigeria and Kenya.

The observations presented here are drawn from interviews with engineers and physicists in Indian universities, and with mathematicians and zoologists affiliated with the University of Ibadan, Nigeria and the University of Nairobi,

Kenya. One hundred and fifteen Indian engineering professors were interviewed in 1971-72 in connection with a study of graduate training received in American universities during the 1950's and 1960's.[13] In order to ascertain whether such training had any long term professional effect, engineers who had received their undergraduate and post graduate education in Indian universities were also studied. About half (45%) of those surveyed were employed by affiliated colleges; 23% by universities; 10% by the regional engineering colleges; and 22% held appointments at an Indian institute of technology or national institute deemed to be a university.

In 1977, fifteen professors of physics at the University of Bombay and one of its affiliated colleges were interviewed in a pilot study of networks of professional communication linking university scientists with national research institutes in the Bombay area. Nigerian and Kenyan scientists were interviewed in 1978 in a study of the universities of Ibadan and Nairobi. Attention focused on the mathematics and zoology departments. These were selected for the purpose of comparing fields which differ in their relationship to national science priorities that emphasize applied research. Thirty-four African mathematicians and zoologists were interviewed, the term African comprising in Kenya, Ugandan expatriate scientists as well as Asians who have become Kenyan citizens.

Although conceived independently, the three studies elicited similar information pertaining to the careers and research activities of scientists. Subsequent analyses of the interviews suggested important commonalities reflecting conditions of intellectual peripherality characteristic of scientific communities in many Third World countries. Important differences were noted

as well. These had mainly to do with the organization of scientific work and the recency and scale of the country's scientific development. The comparison of scientific life in Indian and African universities presented here is, therefore, undertaken in an effort to indicate the ways in which university science is shaped by its peripherality as well as by its institutionalization in these societies.

The Implantation of Science in Indian and African Universities

India's universities are among the oldest in the Third World. As in Europe and North America, the development of colleges and universities in India preceded the systematization of secondary and primary education. The first Indian colleges were established at the turn of the 19th century, many on the initiative of Orientalists in the employ of the British East Indian Company who sought to foster the revival of Hindu and Muslim learning.[15] The incipient Indian bourgeois, however, desired education offered in the language of colonial rule and facilitating access to Company employment. With the encouragement of the Company, they established colleges promoting western learning which, by the 1830s, had received the Company's as well as Parliament's endorsement. Education in the English medium was made a prerequisite for entry into the colonial civil service. Colleges of oriental learning atrophied while institutions offering western learning proliferated to such an extent that at mid-century it became necessary to exert a measure of control over their expansion. The instrument chosen for this purpose was the affiliating/examining university, inspired by the University of London, which provided an organizational framework for the development of Indian higher education. Despite its failure to control expansion, the affiliating/examining university which divorced instruction from examination has survived with slight modification to the present day.

Indian science and technology developed largely outside the framework of higher education during the first half of the 19th Century. However, the mid-19th Century Indian universities---like those in Ireland, Scotland and Canada---more readily accepted the "practical arts" as appropriate subjects for higher education than their counterparts in England. The first Indian colleges of technology, for instance, appeared in the late 1840s.[16] The assumption of direct rule after the Mutiny of 1857 and the resulting expansion of public works provided an impetus to the development of engineering education. Significantly, while engineering soon found a place in Indian higher education, instruction in the physical sciences developed very slowly. In this regard India lagged behind the British universities and those established by Britain in North America where the applied sciences were developed in conjunction with the physical sciences. Indeed, scientific studies were not fully developed in many India universities until the turn of the century, owing largely to the fact that the affiliating-examining model, predicated on the faith that bureaucratization and external scrutiny were the best guarantors of standards, inhibited the emergence of new fields of study. This had become painfully evident to Indian educators and colonial officials from the 1870s onward.[17]

Science was more fully developed in institutions external to the affiliating/-examining framework. In 1909, the Indian Institute of Science was established with an endowment provided by the Tata Trust. "to promote India's material and industrial welfare."[18] Within a short time, the Indian Institute of Science obtained international prominence especially in physics, the field in which Raman received a Nobel Prize in 1930. Despite such accomplishments and the subsequent expansion of scientific training and technical studies in universities at the time of independence, India's infrastructure of scientific training and research

was in important respects "underdeveloped." Engineering studies were not articulated with instruction in the physical and social sciences. Science programs in Indian universities were most developed where resource requirements---good laboratories and adequate instrumentation---were modest (in mathematics, for example). There were few post-graduate programs in science and engineering. At most universities, research was not integrated into the professional responsibilities of staff, a legacy of the collegiate tradition of the early 19th Century and of the routinization of academic work that followed the adoption of the affiliating/examining model.[19] Since independence, science and engineering programs have expanded. A parallel system of scientific and technical education was created with the establishment of the Indian institutes of technology. But these transformations have had little effect on the science and engineering programs of universities, which are the mainstream of Indian higher education.

Higher education evolved very differently in Nigeria and Kenya. Institutions of higher education in the two countries were established after World War II in preparation for eventual independence. In Africa, as Ashby has observed, the decision to develop higher education oriented to western learning was instinctive and did not arise from debate over whether higher education should foster the African or the European intellectual heritage.[20] On this, the colonial authorities and the African bourgeois were in agreement. Perhaps reflecting on the Indian experience, colonial authorities in Africa favoured slow growth of the educational system; the development of higher education being preceded by the elaboration of academic secondary education conforming to metropolitan standards. School-leaving examinations, set in Great Britain, were the mechanism for ensuring adherence to metropolitan standards. When the first universities were established

in Nigeria and Kenya, a similar device was used. The University of Ibadan, Nigeria's oldest university, was founded in 1948 and affiliated to the University of London for examining purposes.[21] Makerere University, founded shortly afterward (1949), was also affiliated to the University of London as was its constituent college at Nairobi, which had been a technical college before its elevation to a university college in 1964. The resemblance to the affiliating/examining framework of the Indian higher education is superficial. Indian universities were never affiliated to metropolitan institutions.

Instruction in the physical and biological sciences commenced with the establishment of Ibadan, Makerere, and the University College at Nairobi. Although Nigerian and Kenyan students continued to pursue scientific studies abroad (and indeed do so to the present day), the intention was to provide opportunities for scientific training up to the first degree, locally, so that foreign study would be required mainly at the post graduate level.[22] Only when undergraduate scientific studies had achieved a metropolitan standard would post graduate programs be developed. As at the undergraduate level, metropolitan standards would be ensured by external examination (as well as the continuing participation of expatriate professors in positions of responsibility).

Nigeria, the larger and wealthier of the two countries with the longest tradition of higher education, embarked on expansion of its system of higher education during the transition from colonialism to independence. In the first years of independence, three universities were established, Nssuka (1960), Ife (1961) Amadu Bello (1962) and Lagos (1962). Less than a decade later, following its civil war and discovery of oil, Nigeria again expanded its system of higher education creating nine new universities (at Benin, Calabar, Maiduguri, Ilorin,

Sokoto, Port Harcourt, Jos, Calabar and Bayero). Eleven universities now offer instruction in the natural and biological sciences at the undergraduate level. By 1977-78, 5 341 Nigerians were studying for undergraduate degrees in the sciences and 303 for post graduate degrees, an increase of 627% at the undergraduate level and 445% at the post graduate level since 1967-68.[23] Engineering education has grown even more dramatically.

Such expansion marked a significant departure from colonial policy that was foreshadowed by the termination of Ibadan's affiliation with the University of London when Nigeria became independent in 1961. (Ibadan itself became an "affiliating" university and was associated with the founding of universities at Ife and Jos). The intention to expand higher education soon after independence precluded orderly development. Still, despite the pressures for expansion which were accompanied by as yet unfulfilled expectations that Africans would soon replace expatriate academic staff, Nigerian universities remain committed to the principle of maintaining metropolitan standards.

Kenya has been more cautious in its expansion of higher education. With the dissolution of the University of East Africa in 1970, Nairobi became an autonomous, degree granting university and since the disruption of Makerere during the Amin regime it has become the region's premiere institution of higher learning. It is Kenya's only university. While in Nigeria, aspirations for equality of access to higher education could only be satisfied by establishing universities in virtually every state, in Kenya such rivalries resulted in a policy of gradualism.

For a while it seemed that Kenya would follow Nigeria's path. In 1972, Kenyatta College (formerly a normal school) was established and affiliated to the University of Nairobi. Its location and the initial composition of

its staff and student body suggested an attempt to provide privileged positions to politically influential ethnic groups. After giving serious consideration to upgrading Kenyatta College to university status, the government converted it, in 1978, into a campus of the University of Nairobi offering teacher training programs. Kenya has recently announced its intention to establish a second university at a site as yet undetermined. Efforts to ameliorate ethnic imbalances have taken the form of "affirmative action" in admissions and staffing at Nairobi. Instead of dramatically increasing opportunities for higher education, Kenya has preferred to change the composition of its university.

Autonomy and Authority

The conception of academic work as a profession characterized by a high degree of autonomy and of the university as a self-governing community of scholars was transplanted to Africa through foreign training and continuing contact with expatriates, and embedded in the patterns of governance and collegial "traditions" of the Nigerian and Kenyan universities. The much older Indian universities have a different inheritance. Since the mid-19th century, academic work has connotated little autonomy or collegiality except in the recently established Indian institutes of technology, whose patterns of governance reflect their sponsorship by the United States, the United Kingdom, and West Germany, and many of whose staff have received post graduate training in these countries. Yet, in the Indian institutes of technology, and in Nigerian and Kenyan universities, autonomy and collegiality compete with another conception of academic life, derivative of colonialism but Indian and African in application - a conception of academic life emphasizing generational authority and hierarchalism. Autonomy and authority influence different dimensions of

the academic culture of Indian and African Universities.

In his description of the University of Ibadan, Power and Privilege at an African University, Van den Berghe characterized the senior academic staff of that university as a mandarinate i.e. "the successor class to colonial administrators whose privileges they inherited."[24] Van den Berghe observed that that the professorate "largely regards the university as theirs in a quasi proprietary sense." This is in part reflected in the strong commitment to a tradition of participation in university governance acquired during the period of affiliation and expatriate predominance.

At Ibadan and Nairobi, the Senate is the most important instrument of university governance. In contrast to the Indian universities which have somewhat similar patterns of governance, the senates of African universities are more influential in formulating academic policy. As in the British universities, academic work and academic management are considered as complementary and governance as a collective obligation. Academic responsibility is rarely delegated to the administration (or to lay and governmental authorities) and is jealously defended against encroachments by the university's administrative officers. On the other hand, the Indian universities (even the Indian institutes of technology), have more "presidential" patterns of governance and traditions of professorial subordination to administrative authority.

Ibadan and Nairobi are federal, multi-ethnic universities and the necessity of managing ethnic tensions enhances their traditions of autonomy and collective governance. Both have a commitment to ethnic diversity in student admissions and staff recruitment and have retained English as the medium of instruction partly for this purpose. In India, the expansion of higher education has resulted in parochialism as most universities have adopted the regional language

as their medium of instruction, not only in Arts, but in science, and in some instances in engineering as well. Even India's national universities and institutes (which have retained English as the medium of instruction, admit students through national examinations and advertise staff vacancies nationally) have become increasingly parochial.[25] In regard to student enrollment and staff recruitment, the national universities and institutes have become regional institutions, so strong are the pressures to satisfy parochial interests.

Nigeria, in establishing universities in each of its states has responded to similar pressures which are generated by colonial legacies of unequal access to higher education, on the one hand, and by aspirations for social mobility generated by independence, on the other. Although it too has become more parochial in student admissions and staff recuritment, Ibadan has resisted pressures, surviving the conflict culminating in Nigeria's internecine civil war to remain a national university, perhaps a reflection of the deference displayed toward it by even the most strident proponents of ethnic interests. While the multi-ethnic character of Ibadan and Nairobi contribute to a climate of political intrigue accompanied by suspicions of ethnic favouritism in appointments and promotions, this reinforces their traditions of autonomy and collective governance. Intrusions of government into university affairs or administrative interference into the affairs of faculties and departments are firmly opposed (even by staff who might derive short term benefit since that would exacerbate ethnic tensions). Such interference is a common occurence in the few pluralistic Indian universities where linguistic, communal caste factions among the professoriate

(and student body) seek alliance with counter part groups in the university administration and within the political system.[26] In India, parochialization of student admissions and staff recruitment serve to reduce these tensions.

Collegiality and autonomy compete with authority and hierarchalism in ways that express the African intellectual culture of Ibadan and Nairobi and emphasize their commonality with Indian institutions of higher education. Differentiation of academic staff according to rank is very pronounced in Indian and African universities. Professors at Ibadan, Nairobi and the Indian universities are allocated more spacious housing, have greater access to research funds, and enjoy more influence in university governance than staff of lesser rank. Professors constitute an oligarchy responsible for assigning workloads., evaluating staff for promotion, and dispensing such scarce resources as office space and laboratory supplies. Departmental headships rotate among the professors if there is more than one. Because of staffing difficulties, the tenure of a department head can be very long with no provision for review. Younger staff are conspicuously less well-off materially, have more substantial instructional and supervisory responsibilities and are virtually without influence in the university. Junior staff apprentice themselves to influential senior colleagues, ackrowledge them as co-authors of papers they have written and solicit their advice on professional and personal matters. But this inter-relationship of age, rank, and privilege is not as controversial as it would be in a western university. In African and Indian societies, age is more highly valued and in the colonial, hierarchal traditions of their universities, seniority is more closely related to autonomy and responsibility than in our own. For this reason, there is acceptance of

inequalities based on age and rank and a feeling that this is appropriate. Consequently, traditions of autonomy and authority co-exist but influence different dimensions of academic life. Autonomy is influential insofar as it effects the activities of senior academic staff. It is a privilege, like material privileges, distributed according to an academic's rank.

Cosmopolitanism and Localization

The universities of Ibadan and Nairobi were developed, I have noted earlier, in affiliation with the University of London, to maintain metropolitan standards of excellence. Today, both are autonomous universities. Yet, in contrast to the Indian universities they have consciously sought to retain their cosmopolitanism not only in the recruitment of students and staff but also in their curricula, still influenced by the practices of metropolitan countries and monitored by external examination, but also in regard to the encouragement given to staff to obtain international recognition through their research. The research ethos is deeply embedded in the rhetoric of academic life at Ibadan and Nairobi. This is not the case in Indian universities, however.

At the universities of Ibadan and Nariobi, senior lectureships and professorships are fiercely contested by internal as well as external candidates. Some evidence of scholarship and international recognition is required for promotion to a senior post. Belonging to the "right" ethnic group may be necessary but is seldom a sufficient precondition for promotion. Apparent violations of the application of scholarly criteria in professional advancement occasion acrimonious controversies. Publication is viewed as essential by staff at Ibadan and Nairobi for securing visibility and influence for themselves institutionally.

The universities of Ibadan and Nairobi inherited, from the colonial period,

a reputation for excellence reflecting the rigorous international standards applied to instruction at the first degree level which were often said to be more rigorous than the standards of the University of London to which each was affiliated. This legacy has been largely respected since the two universities became autonomous. While fears are expressed (by African as well as expatriate staff) about falling standards and declining international prestige, the commitment to international standing remains.

In Indian universities, professional advancement is contingent on seniority rather than scholarship. Even though senior posts are advertised in the civil service tradition, vacancies are almost always filled by internal candidates differentiated in terms of the date of their initial appointment. (Experience at other institutions is rarely taken into account in determining accrued seniority, restricting inter-institutional mobility). Indian universities developed as teaching institutions. While post-graduate training has become central to the work of university departments, staff research has not.[27] Consequently, research is seldom recognized in professional advancement.

Research is accorded greater importance at the Indian institutes of technology whose development has been shaped by the assistance of American and other western universities. The institutes perceive themselves as belonging to an international community of English medium engineering institutions. (This has caused some embarrassment as many graduates of the Indian institutes of technology have undertaken further studies abroad and have remained there. Since the engineering programs of the institutes replicate those of the best engineering institutions in developed countries, graduates encounter few difficulties in obtaining employment or opportunity for further study abroad).[28]

Significantly, Indian institutes of technology are, despite concessions to regionalism, national institutions and their adherence to international standards is as much a functional adaptation to circumstances of ethnic pluralism as an indication of their affinity to the intellectual culture of western universities.

The cosmopolitan orientation of African universities and of institutions like the Indian institutes of technology does not suggest insensitivity to the university's role in national development. The contribution of universities to national development in Africa and India focuses primarily on the task of qualifying individuals to work in skilled occupations requiring higher education. Nigeria and Kenya practice manpower planning in post-secondary education, i.e., the size and scope of university programs are determined in accordance with anticipated manpower needs. Inasmuch as the public sector is the employer of most university graduates in African countries, manpower planning can be carried out with seeming efficacy. India has a more developed private sector and while manpower planning is undertaken at the National (Centre) and state levels, universities have considerable autonomy in determining the size and scope of their programs. Engineering and a few other professional programs which have received special Centre grants and whose high costs are the object of much political attention are an exception to this. Whereas Nigerian and Kenyan universities have been preoccupied with satisfying the manpower requirements established by various ministries, Indian universities produce manpower "surpluses" that the labor market cannot easily absorb through inflation of educational qualifications. Graduate "unemployment" has been a persistent problem receiving sporadic attention from Indian educators

since the 1880s.[29] Having permitted the participation of private associations articulating communal, linguistic or caste interests in the development of higher education during colonial rule, it is difficult to bring expansion of the university system under control.

Nigeria, which has "regionalized" higher education may soon follow India's example, perhaps finding itself in a more precarious situation given the implicit obligation of the public sector to employ university graduates. But for now, Nigerian and Kenyan universities experience difficulty in keeping pace with manpower needs. The aspirations of university graduates for highly renumerated employment are generally fulfilled (notwithstanding, the inevitable deterioration of opportunities for social mobility for successive generations of graduates). This has given rise to a unique expression of the university's involvement in national development: the encouragement of private entrepreneurship by professorial staff.

In the colonial tradition of Indian and African universities, professors, like other public servants, were not allowed to accept additional employment. Today, professors at Ibadan and Nairobi are actively involved in consulting and in commercial pursuits which are often unrelated to their university responsibilities.[30] This is openly encouraged and desired as a mechanism for enlarging the pool of African entrepreneurial talent. Regulations requiring the reporting of some consulting activities have recently been introduced in Nigeria and Kenya, though not with the intent of discouraging this form of involvement in national development.[31] The staff regulations of most Indian universities explicitly discourage efforts to supplement the meagre income of staff.[32] Some earn extra income from tutorials or from royalties received from the preparation of examination guides.

But only the Indian institutes of technology have given encouragement to consulting through granting requests for unpaid leaves of absence and permitting professors to retain a modest portion of their consulting fees.

Policies fostering consulting (and professorial entrepreneurship) in Nigeria and Kenya reflect the prominent role of the university in applied research. While the responsibility for performing fundamental research in national science planning is delegated to universities, in fields requiring large expenditures for research equipment, technicians and assistants, only limited funding is available for such research. This encourages university scientists to seek funding from government ministries and research councils which support research of a short-term nature with a "developmental pay-off". Government research institutes in Nigeria and Kenya have not evolved to the extent that they can satisfy national requirements for applied research.

India's larger scientific community and older, more fully elaborated network of governmental research institutes have permitted a more clearly delineated division of scientific labor.[33] Indian universities contribute very little to satisfying national requirements for applied research. And, fundamental research in many scientific fields, such as high-energy physics and genetics, is more the responsibility of government research institutes than of universities. The absence of a research tradition in most Indian universities is, thus, exacerbated by inadequate funding of research of an applied or a fundamental nature.

Careers of Indian and African Scientists

African scientists, like most other Africans with higher education, are usually the first in their families to receive secondary and higher education.

Many particularly in Kenya, come from rural backgrounds. Most of the senior staff interviewed at Ibadan and Nairobi took up science in the late 1950s and early 1960s, when scientific training was much favoured by government but under conditions unfavourable to a scientific education. Science was a subject studied from obsolete texts, expounded by teachers with little scientific training and regurgitated at examinations.

This first generation of Nigerian and Kenyan scientists, many of whom now occupy important administrative positions in universities and government ministries, studied abroad. For most of these senior scientists, the aspiration was to join government service as a secondary schoolteacher. A first degree abroad was often followed by a diploma in education taken at Makerere or Ibadan and several years of teaching secondary school. As secondary school teaching became less prestigious, their interests turned to post graduate studies. Government stipends and foreign scholarships were made available to those seeking advanced degrees abroad, many of whom anticipated an appointment on return at one of the new universities established after independence.

A university appointment signified entry into the elite of Nigerian and Kenyan society. University life afforded amenities not available to even some of the most advantaged Nigerians and Kenyans; subsidized housing, for example. Most senior scientists emphasize their humble origins in comparison with their present, often enviable circumstances. A career as a university professor is often valued as much for the material privileges it affords as for the opportunity for independent inquiry. The following biography of a professor of zoology at the University of Nairobi (constructed through merging information received from several scientists) is illustrative of the careers of many senior staff.

Professor M...speaks rapidly in Oxford-accented English, smokes pipes and, surprisingly, given the very formal conventions of academic life at the University of Nairobi, he dresses casually in cardigans and "cords". Professor M...is the director of a research institute attached to the Zoology Department on the University campus. His office is large enough to accommodate a special seating area for guests. Pictures of Professor M...adorn the walls of his office. Visitors are seated in leather-backed chairs around a coffee table near Professor M...'s desk. A guest book is placed on the table. In it are the names of several scientific attachés from Nairobi embassies, representatives of philanthropic foundations, officials of international educational and scientific organizations, and professors from universities in various parts of the world. Professor M...is very adept in his dealings with visitors. He is forceful and articulate, evidently accustomed to pleading his case.

> "Although I'm from an urban culture," Professor M...related, "several members of my family on my father's side are associated with fishing...an uncle was particularly influential in regard to (my) decision to become a zoologist." "My uncle," Professor M...explained," liked to collect snakes and spiders to surprise people...he had a way with animals and I admired him very much." Professor M... studied biology in secondary school and in 1954 won a scholarship that permitted him to enter the pre-med program at Makerere. For various reasons, including the fast-paced lifestyle of medical students (Professor M...is a devout Muslim), he withdrew from the program and decided to do a diploma in education. Afterwards, Professor M...taught biology at the secondary school level. An expatriate professor whom he encountered during the diploma program at Makerere interested him in the ecology of ponds - an interest Professor M... tried to convey to secondary school students through field trips.
>
> In 1957, Professor M...won a scholarship to study his B.Sc. in the U.K. and six years later returned with a Ph.D. in endocrinology, specializing in the endocrinology of tellepia (a species of fish prevalent in many tropical countries). Professor M...was fortunate enough to study for his post-

> graduate degree under the direction of a zoologist with experience in the tropics who encouraged him to do research on a subject pertinent to African conditions. On completion of his Ph.D., Professor M...was recruited to the University of Nairobi where he was among the first Kenyans to hold an academic post in the Faculty of Science. Today, half of the staff of the Zoology department are Kenyans. The department chairmanship, in fact virtually all senior positions in the Faculty, have become Africanized.

In Nigeria and increasingly in Kenya, younger scientists have received their education locally up to the first degree level and as post graduate programs expand, acquire advanced training in Africa as well. Like the first generation of African scientists, the social origins of these individuals are humble. Educated in late 1960s and early 1970s, they received better science education at secondary school and university for science education had become a national priority. The rapid professional advancement of the first generation of African scientists offered evidence of this.

In Nigeria, although the faith in "science for development" remains, enthusiasm is tempered by the realization that scientific and educational goals must be articulated more modestly in view of the present financial stringency. Opportunities for professional advancement at Ibadan and the older Nigerian universities have declined as a result of Africanization of senior positions. The prerequisites of academic life are no longer as favourable either. On-campus housing cannot be taken for granted, for instance. Many Nigerian scientists now express their view that there are fewer professional opportunities and less recognition of the importance of science. This view is more frequently expressed by younger scientists with memories of the national enthusiams for science during the 1960s.

Dr. A...joined the zoology department at the University of Ibadan in 1973 He is one of an increasing number of staff who have obtained their B.Sc. and Ph.D. degrees from this institution. His research interests center on small mammal ecology, interests developed during the Civil War. Shortly after starting his post graduate studies, Dr.A...left the University of Ibadan to serve as an officer in the Biafran Army. For most of the war he was on patrol in the bush where, "with little else to do, I spent a great deal of time observing bushrats and other small mammals that are important sources of protein to most Nigerians". On rejoining the university, he studied under the direction of an expatriate who, though not a small mammal ecologist, gave encouragement to his interests and supervised his doctoral research on "bushrats."

Dr. A...'s office is located in one of the faded yellow, cement-faced, tile-roofed buildings that constitute the zoology department and were among the first buildings constructed on the Ibadan campus. The office is air-conditioned to an uncomfortably cold temperature, perhaps in anticipation of the frequent disruptions in electric power. Dr.A...'s desk and a small adjoining table are obscured by stacks of examination papers and scientific periodicals. Along two walls there are counters which are now being used for ongoing experiments with "grasscutters". Balances, microscopes and other laboratory equipment are stored in wooden cabinets above and below these counters. Much of this equipment is unuseable. No spare parts. No maintenance.

By 10:00 a.m., most academic staff have arrived at their offices in the zoology department. Dr.A...drives to the office from his lecturer's flat on campus in an air-conditioned Datsun. Occasionally, Dr.A...will leave his office at noon to go to the university's Staff Club, but he feels uncomfortable spending too much time there. The Staff Club is mainly patronized by senior lecturers and professors influential in university politics (or who aspire to be) as well as by expatriates and their families. Today Dr.A...will drive back to his flat, return in mid-afternoon to meet briefly with a colleague and then work quietly until 5:00 p.m.

Like most Nigerian staff, Dr.A...shares the accommodation the university has allocated to him with numerous relations and, consequently, has no place to work at home. He is fortunate to have obtained accommodation on campus. Many staff live a considerable distance off campus, in more spacious accommodations, but typically without even intermittent water and electricity, and due to fear of physical violence, are reluctant to travel to or from their offices after dark.

> Dr.A...began university in his late twenties, shortly after Nigeria received its independence, when, he notes, a scientific career was very prestigious. He selected zoology as a field of specialization as a result of a childhood interest in the natural world and partly because "it required less mathematics than other scientific disciplines". At the outset, Dr.A...planned a career as a science teacher at the secondary school level. After completing his B.Sc., Dr.A...accepted an appointment at a secondary school in Port Harcourt, his place of birth. Soon he became disenchanted with school teaching. At the urging of a former professor, he applied for admittance to post graduate studies at the University of Ibadan, which was expanding its post-graduate programs. Dr.A...also applied (successfully) for a Federal stipend to study at a leading university in the U.K. but chose to continue his studies at Ibadan out of belief that graduate training there "would be more pertinent, more relevant to what I would be doing later in my career".
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> Dr.A...is the only small mammal ecologist in the Zoology department. No post-graduate students work in his area of specialization. Small mammal ecology, according to Dr.A...is not considered significant, it's seen as a waste of time, although small mammals are significant to the common man". For this reason, Dr.A.feels that he is unable to secure research funds and must change his research interests. "Today",he observes, "there is much cynicism about science... some of (it) imported from western countries, some arising from the belief that science would solve all of our problems, a view that government held but most scientists did not".

The disillusionment and frustration reported by many younger scientists at Ibadan were not evident at Nairobi. Once the University of Nairobi has Africanized its academic staff, (in 1978, expatriates accounted for about half of the staff at the lecturer level and above), opportunities for professional advancement may decline there too. Still, the University of Nairobi is unlikely to undergo the dramatic expansion and subsequent contraction which occurred in Nigeria, if only because Kenya lacks the financial resources which permitted Nigeria to expand so rapidly.

The social context of a scientific career in an Indian university is very different. Most university professors in India are drawn from the urban

bourgois and from families with experience of formal education often spanning several generations. A career as a university scientist is attractive primarily to those who are unable to pursue other, more remunerative occupations requiring similar qualifications or who are not disposed to seeking material advantage (i.e., individuals from families as well as from caste and linguistic communities which value learning and the high traditional status that teaching affords). It is also a career selected by those who prefer the security and predictable rewards of government employment to the ambiguities of the private sector. A university career is not for the socially and financially ambitious as is the case in many African countries.

The professional rewards of a university career in India are uncertain. Advancement is dependent on seniority. There are few opportunities for recognition institutionally or professionally. The energies of younger staff are exploited by senior staff. Self-effacement is necessary during the long period of time an individual must wait for promotion to a senior position. Junior staff must be willing to suppress their professional interests, to do the bidding of others often with no prospect of immediate gain or certainty of eventual reward. It is not unusual to encounter staff who because of the timing of their appointment and the small number of senior positions cannot look forward to promotion and because of the reluctance of universities to appoint external candidates to senior positions, cannot obtain employment elsewhere.

The professional work of most university scientists in India including those employed at national universities and institutes of technology, centers on teaching often to the exclusion of research and other scholarly activities.

As in many African universities, undergraduate teaching in Indian universities is oriented to the preparation of students for examinations. But compared to African universities, teaching is more routinized due to the fact that the curricula and syllabi are largely determined externally, i.e., by university departments in collaboration with the affiliated colleges where undergraduate instruction is carried out. Course instructors assign a variable portion of the final marks, seldom high enough to compel students to take their lectures seriously unless they concern examination topics. Moreover, while African university students are a "presumptive" elite exhibiting affinity to the political system that selected them for future privilege, Indian students perceive themselves as being disenfranchised and adhere to a tradition of opposition to the state that predates independence. Student unrest in Nigeria and Kenya universities is sporadic. In India, it has been, except for the brief period of emergency rule, a chronic condition. The feelings of frustration resulting from the bureaucratization and adversity of academic life in Indian universities which give rise to student unrest are shared by many staff for whom scientific work provides little intellectual stimulation or reward as thie biography shows:

> N. is 30 years old, a lecturer, and teaches at N.R. Engineering College which is located near the university's main campus on the periphery of a small, industrial district. In contrast to the spacious and well-arranged appearance of the various university faculties, N.R. Engineering College is compact and cluttered with classroom buildings and workshops. Most academic buildings are organized around a small rectangular open space which is turned into a cricket field during the late afternoon. Aside from two clay tennis courts converted to volleyball courts, this is the only recreational area at the college. Academic buildings and laboratories have been vandalised several times in the past year, and left unrepaired in anticipation of further violence.

At present, N.R. Engineering College is six months behind its examination schedule. Last year, student disturbances forced postponement of the annual examinations. Most staff feel that student agitation is primarily the work of outside political forces which have manipulated student frustrations.

The registrar of N.R. Engineering College estimates that there are about 1,100 engineering students on campus including many who are simply waiting to retake failed examinations. Most students live in hostels inside the campus compound. Rooms are small and crowded, there are no fans, lounges or study areas. Some staff housing is provided on campus, and fifteen years ago all faculty resided at the college. Today, there is not sufficient accommodations for all department heads.

> N. arrives at the college about eight o'clock on most days and will stay until five. He spends much of the day supervising practicals (laboratory sessions) for third-year students. His lecturing responsibilities are minimal and require little preparation on his part. What is to be taught has been decided by others. When N. lectures, it is at dictation speed in a mixture of English and the local language. Students rarely ask questions at any time. Reproduction of their lecture notes will suffice for the examinations. After his classes are finished, N. spends his "free time" advising student organizations (such as the student canteen) and completing stores requests for his department head.
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> N's office is on the first floor of the civil engineering building off a large area that was once designated to serve as a laboratory. The equipment to fill it never arrived. Outside N's office is a plain wooden bench at one end of which sits a clay water jug. The bench is meant to be used by students waiting to see N. (Staff and important visitors simply barge in.) The office is entered through a swinging door. Inside, the walls are bare except for a calendar. N's books and files are piled in stacks on the floor. In the centre

of the room is a small desk, covered with a plastic tablecloth on which is a full glass of water with a tin saucer on top placed there daily by the departmental servant.

N. has taught at N.R. Engineering College for three years. Before that he was briefly with a State Public Works Department. N. obtained his Master's degree from the same institution where he now works. While N. gives the reasons most faculty cite for taking up teaching ("I've always loved to teach; I don't care much about material things"), he admits that his career in the Public Works Department was not very bright due to strained relationships with his superior. N. began teaching soon after finishing his Master's degree. He first considered positions in the private sector, but he had no "connections". A major reason for joining the Faculty at N.R. Engineering College was the personal attachment N. had to his major professor, now his department head. N. has collaborated with his department head on several research projects funded by the national government. In the few publications resulting from this research, N. appears as third author, behind the names of his department head and another colleague who is a Reader. N. says he has done most of the work. He does not feel resentful about this lack of recognition - perhaps because his department head has had the foresight to send him to several national conferences as the representative of the research "team". N's future at N.R. Engineering College is encouraging. He is third in seniority in his department. His department head is nearing retirement, and the man that will replace him is in his late forties. Dr.N. is resigned to waiting out the better opportunities that will come ultimately with the passage of time and the advancement of rank. The token recognition he has received from his department head and the likelihood of future promotion are sufficient inducement for him to accept with equanimity the frustrations of his junior position and of academic life generally.

In sharp contrast to the malaise which characterizes the careers of scientists and engineers in many Indian universities, most Nigerian and Kenyan scientists are imbued with a sense of the importance of their work and its centrality to the development of their society. In recounting their accomplishments--invitations to professional conferences, publications appearing in foreign journals, research funds received from international scientific organizations and so on--Nigerian and Kenyan scientists stressed that these were a source of collective pride, African accomplishments to be recognized as such by others. Though Western colleagues may doubt the existence of an African

science, few Africans do despite the fact that they readily acknowledge the universality of science and have an ill-defined concept of the specifically African nature of their work. The task of building a scientific community (whose contributions to the development process is seen as self evident) is spoken of with enthusiasm. Absent is the cynicism so frequently expressed by Indian scientists: "Science cannot develop in a society riddled with superstitions;" "No serious scientific work can be done here;" "The scientist's situation has worsened...there is no longer the sense of committment and purposefulness (among scientists) that existed prior to and just after independence," etc. That India is the most scientifically developed Third World country is rarely acknowledged. India's older scientific traditions and high level of participation in the international scientific system may have the effect of exacerbating rather than ameliorating its peripherality. In other words, India's scientific development may increase awareness of its "underdevelopment".

Nigerian and Kenyan university scientists do not seem as pre occupied with their peripherality. In part, this may be attributable to their greater contact with metropolitan scientific communities. Most have received some scientific training abroad. Until recently, Nigerian and Kenyan universities were generous in allocating funds to facilitate professional travel. Study leaves and sabbaticals are spent in Western countries. Many international scientific and educational organizations have regional offices in Nigeria and Kenya and provide research funds to African scientists. Large number of expatriate scientists hold teaching positions in African universities. This fosters the impression that African science is recognized internationally. As Nigeria and Kenya expand their infrastructure of scientific training and research, opportunities for contact with the international scientific system will diminish, their scientific communities will become increasingly differentiated and feelings of intellectual isolation may well be more prevalent. There are already indications of this in Nigeria.

Conclusion

In comparing scientific life in Indian and African universities, I have intended to suggest how science is shaped by factors associated with its development, its institutional context and with the political and social meaning of a scientific career. The scientific communities of India, Nigeria, Kenya and other Third World countries are peripheral; scientific work is shaped by the concerns of countries prominent in the production of science from whom they seek recognition and to whom they are peripheral. In varying degrees India, Nigeria and Kenya are scientifically "underdeveloped". Of the three countries India is the most scientifically developed. The scientific communities of Nigeria and Kenya are more recent, much smaller and have less fully elaborated infrastructures of scientific training and research. Science was implanted in Indian universities at the time of its emergence in many Western universities. Nevertheless, the organizational framework of Indian higher education--the affiliating/examining university--has given rigidity to scientific training and fostered indifference toward research as a professional obligation. The expansion of higher education prior to and following independence had important parochializing effects insofar as the development of science is concerned.

In Nigeria and Kenya, science was largely neglected until decolonization and independence. Unlike India, higher education in African countries has become the principal axis of their scientific development. Ibadan and Nairobi, Nigeria's and Kenya's most influential universities are now autonomous.

Nevertheless, they have remained committed to ethnic pluralism and to the maintenance of an international standing. The two universities, though faithful to western intellectual traditions, have given African expression to these traditions as the Indian universities had done much earlier. In this connection, the academic culture of Indian and African universities exhibit certain similarities in regard to the importance of generational authority, for instance. But there are, in addition, profound differences. Political and administrative intrusions into academic affairs are more characteristic of Indian universities as is the limited participation of the professoriate in national development.

In India, Nigeria and Kenya, scientific development is a national priority. In India, however, national science policy has benefited scientists working in the new universities and institutes established since independence which are independent of the affiliating/examining framework. The conditions of scientific work in universities and their affiliated colleges, which have experienced the greatest expansion in enrollment, are conspicuously poorer. Still, a career as a scientist in the best Indian institutions does not convey the prestige, privilege or national and international visibility it does in African universities. This may be due to the recency and to the limited scope of African scientific development. As Nigeria's and Kenya's scientific communities mature, the careers of university scientists may more closely resemble those of their Indian colleagues as university science becomes increasingly less important and as their systems of higher education become more localized in response to the desire for a greater measure of self-sufficiency in scientific training and research.

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